

NetSolve, Its Applications, and the IPG

Jack Dongarra
Innovative Computing Laboratory
University of Tennessee

http://www.cs.utk.edu/netsolve/





NetSolve Team

- Sudesh Agrawal, UTK
- Dorian Arnold, UTK
- Susan Blackford, UTK
- Henri Casanova, UCSD
- Jack Dongarra, UTK
- · Coral Hang, UTK
- Michelle Miller, UTK
- Sathish Vadhiyar, UTK



Innovative Computing Laboratory

NetSolve – Network Enabled Server

- NetSolve is an example of a grid based hardware/software server.
- Easy-of-use paramount
- Based on a RPC model but with ...
 - resource discovery, dynamic problem solving capabilities, load balancing, fault tolerance asynchronicity, security, ...
- Other examples are NEOS from Argonne and NINF Japan.



3

NetSolve

- Target not computer scientist, but domain scientist
- Hide logistical details
 - > User shouldn't have to worry about how or where (issues about reproducibility)
- Not intended for running a task across a grid of machines, but on a single machine on the grid.
- Present the set of available remote resources as a "multi-purpose" machine with a wealth of scientific software



NetSolve Specifics

- Multiple user interfaces:
 - > C, Java, Matlab, Fortran, Web, Excel, Mathematica
 - > Bindings to software components to these interfaces.
- Ready to use out of the box.
- User describes problem and NetSolve finds best available device for the solution.
- Not automagic, the software you want to use has to be installed into the NetSolve system. (Today's version)



۲

The Grid Architecture Picture User Portals Problem Solving Application Science Grid Access & Info Environments **Portals** Service Layers Resource Discovery Co- Scheduling Fault Tolerance & Allocation Authentication **Events** Naming & Files Computers Data bases Online instruments Resource Layer Software Innovative Computing Laboratory High speed networks and routers

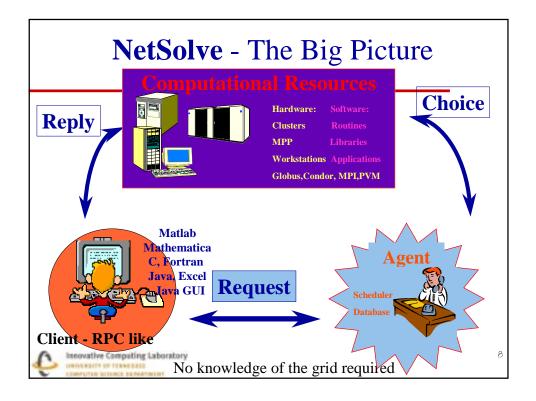
Motivation for NetSolve

Design an easy-to-use tool to provide efficient and uniform access to a variety of scientific packages on UNIX and Window's platforms

Basics

- Client-Server-Agent Design
- Non-hierarchical system
- Load Balancing and Fault Tolerance
- Heterogeneous Environment Supported
- Multiple and simple client interfaces
- Built on standard components

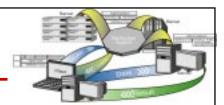
Innovative Computing Laboratory



NetSolve Basic Usage Scenarios

- Grid based numerical library routines
 - Users doesn't have to have software library on their machine
- Task farming applications
 - "Pleasantly parallel" execution
 - > eg Parameter studies
- Remote application execution
 - Complete applications with user specifying input parameters and receiving output





- "Blue Collar" Grid Based Computing
 - Does not require deep knowledge of network programming
 - Level of expressiveness right for many users
 - User can set things up, no "su" required
- Smart Libraries
 - Decision on which algorithm and software based on input data
 - Decouple interface (common component)

а

NetSolve Usage

- A user can install the client, server, and/or agent.
- Easy to setup a "private" grid or join the "global" grid.
- Users can add software components to a server.
- There can be multiple agents in the system.



NetSolve Applications and Interactions

- Library usage
 - > LAPACK/ScaLAPACK Parallel dense linear solvers
 - > SuperLU/MA28 Parallel sparse direct linear solvers(UCB/RAL)
 - > PETSc/Aztec Parallel iterative solvers (ANL/SNL)
 - > Other areas as well (not just linear algebra)
- Applications
 - > MCell Microcellular physiology (UCSD/Salk)
 - > IPARS Reservoir Simulator (UTexas, Austin)
 - > Virtual Human Pulmonary System Model (ORNL)
 - > RSICC Radiation Safety sw/simulation (ORNL)
 - > ImageVision Computer Graphics and Vision (Graz U)
- Tool integration
 - > Globus Middleware infrastructure (ANL/SSI)
 - > Condor Workstation farm (U Wisconsin)
 - > AppleS Application Scheduling (UCSD)
 - > NWS Network Weather Service (U Tennessee)
 - > SCIRun Computational steering (U Utah)
 - > Ninf NetSolve-like system, (ETL, Tsukuba)



NetSolve - MATLAB Interface

Synchronous Call

- >> define sparse matrix A
- >> define rhs
- >> [x, its] = netsolve('itmeth', 'petsc', A, rhs);

...

- >> [x, its] = netsolve('itmeth', 'aztec', A, rhs);
- >> [x, its] = netsolve('solve', 'superlu', A, rhs);
- >> [x, its] = netsolve('solve', 'ma28', A, rhs);

Asynchronous Calls also available

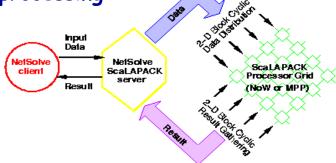
NetSolve - FORTRAN Interface Easy to 'switch' to NetSolve

parameter(MAX = 100)
double precision A(MAX,MAX), B(MAX)
integer IPIV(MAX), N, INFO, LWORK
integer NSINFO

call DGESV(N,1,A,MAX,IPIV,B,MAX,INFO)

Hiding the Parallel Processing

User maybe unaware of parallel processing



 NetSolve takes care of the starting the message passing system, data distribution, and returning the results.

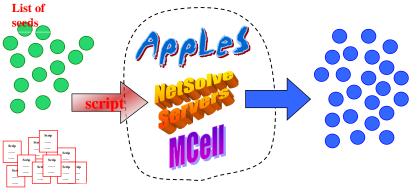
MCell: 3-D Monte-Carlo Simulation of Neuro-Transmitter Release in Between Cells

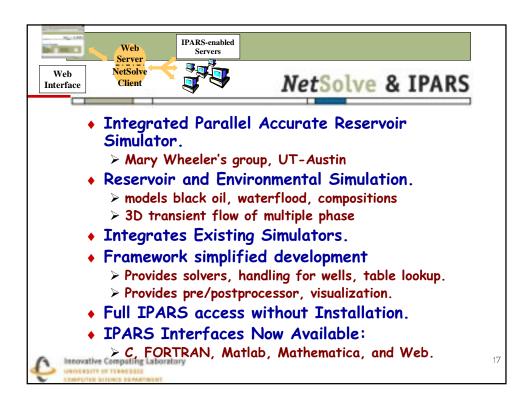
- •Developed at: Salk Institute (T. Bartol), CMU (J. Stiles)
- •Study how neurotransmitters diffuse and activate receptors in synapses
- •blue unbounded, red singly bounded, green doubly bounded closed,



MCell: 3-D Monte-Carlo Simulation of Neuro-Transmitter Release in Between Cells

- •Developed at: Salk Institute, CMU
- •In the past, manually run on available workstations
- •Transparent Parallelism, Load balancing, Fault-tolerance
- •Fits the farming semantic and need for NetSolve
- •Collaboration with AppLeS Project for scheduling tasks

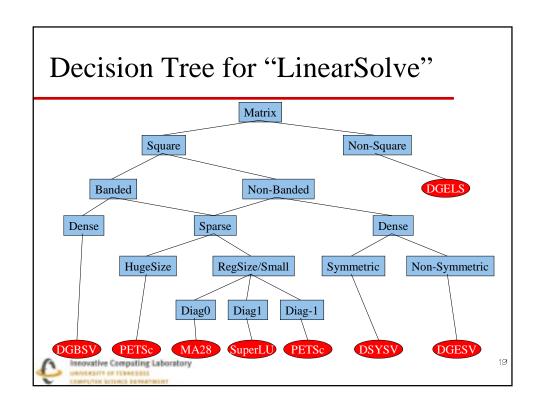


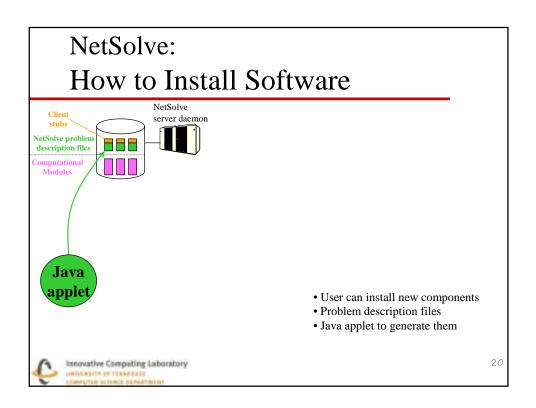


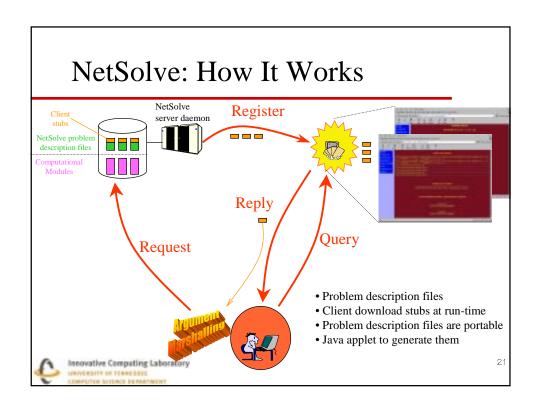
Automated Adaptive Algorithm Selection – Smart Libraries

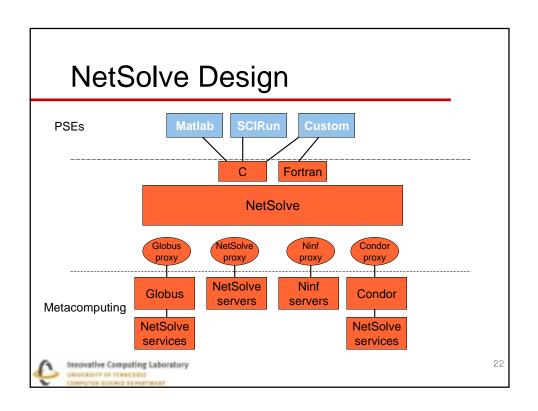
- ◆ Linear Solvers can require expert mathematical knowledge to utilize the right one under the right circumstances - e.g. choosing appropriate preconditioner for an iterative method.
- Installation of these complicated software libraries can be tedious and troublesome.
- Through a generic "LinearSolve" interface, NetSolve alleviates user of the need to decide amongst various types of solvers and provides a uniform interface to all routines.
- Decision based on characteristics of input matrix.











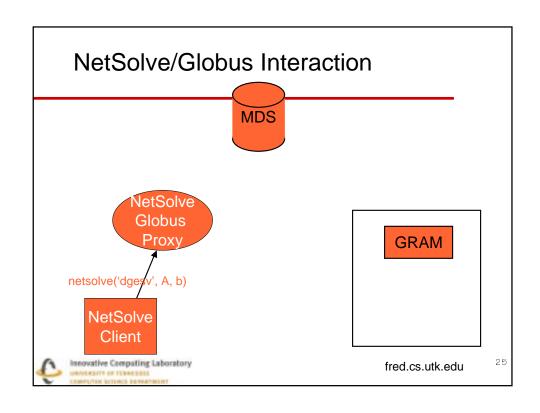
NetSolve and Globus

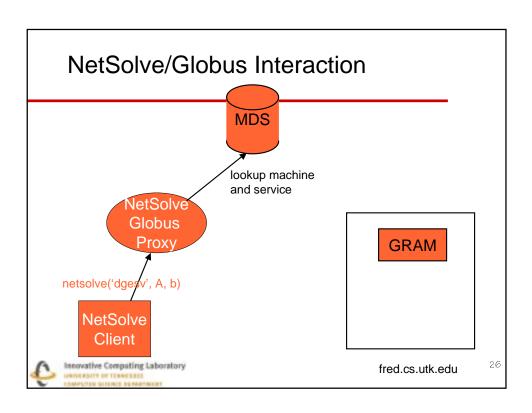
- NetSolve makes use of the MDS to store information about which machines could run certain services
- NetSolve makes use of GRAM to startup NetSolve services

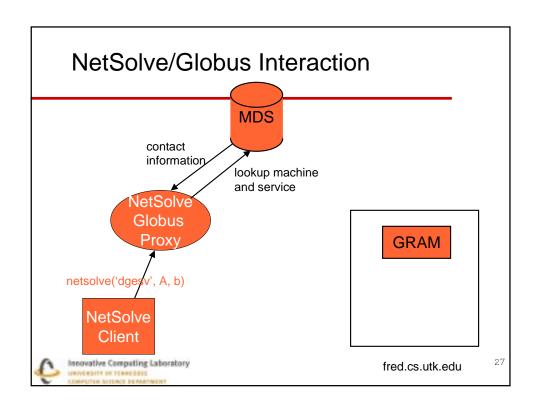


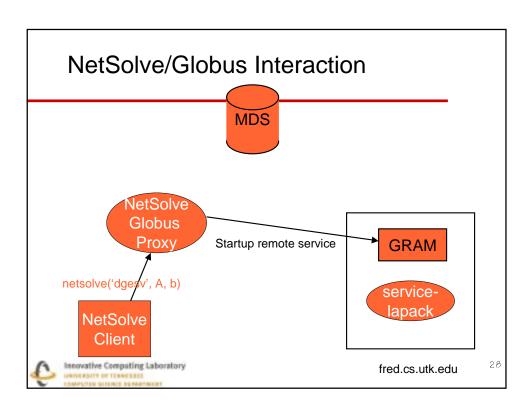
23

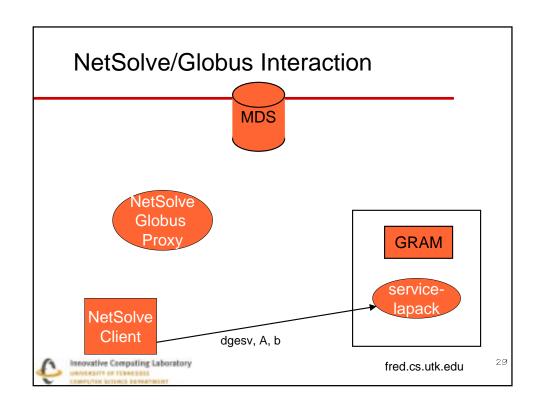
NetSolve/Globus Interaction MDS GRAM NetSolve Client fred.cs.utk.edu 24

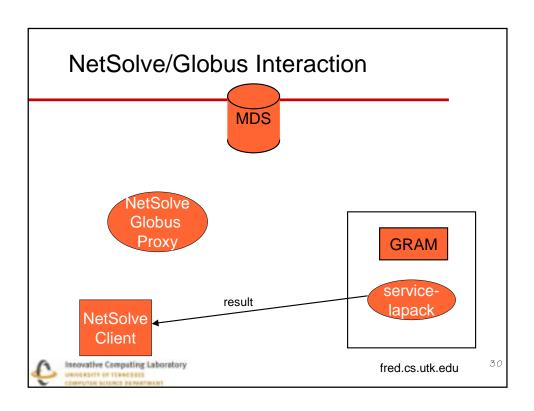




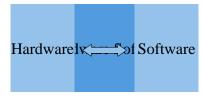








Server Software Repository



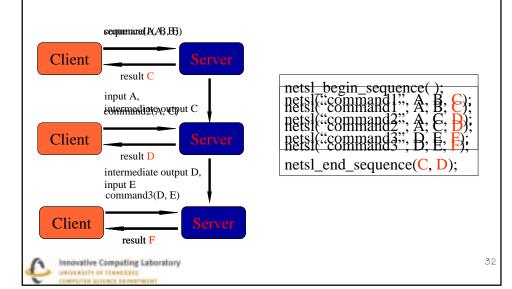
NetSolve Server

- Dynamic downloading of new software.
- Enhance servers capabilities without shutdown and restart.
- Repository maintained independently of server.



31





NetSolve Authentication with Kerberos

- Kerberos used to maintain Access Control Lists and manage access to computational resources.
- NetSolve properly handles authorized and non-authorized components together in the same system.



NetSolve: Features for the Future

- Software repositories
- Data encryption/compression mechanisms
- Smart libraries
- Access control or user accounting mechanisms (tokens, credits,..)
- Computational steering

- Task migration and improved Faulttolerance
- Monitoring system
- ◆ Palm applet...





Software available see:
http://www.netlib.org/netsolve/ (> 18K hits)

